An Instrument for Determining the Partial Pressure of Oxygen in a Gas[1]

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In response to a request by the National Defense Research Committee, we developed in the Fall of 1940 a simple and effective instrument for determining the partial pressure of oxygen in a gas. The operation of this instrument depends upon the fact that the magnetic susceptibility of oxygen is very much greater than that of any other common gas: at 20° C. and one atmosphere the volume magnetic susceptibility of oxygen is $+142 \times 10^{-9}$ c.g.s.m.u., whereas that of nitrogen, which is representative of the common diamagnetic gases, is -0.40×10^{-9} c.g.s.m.u. The magnetic susceptibility of a gas is hence determined almost entirely by the partial pressure of the molecular oxygen in the gas;[2] the effect of adding one atmosphere of nitrogen is equal to that of decreasing the partial pressure of oxygen by 0.0028 atmospheres.

The indication of the magnetic susceptibility of the gas in this oxygen meter depends on the behavior of a small test body surrounded by the gas in an inhomogeneous magnetic field. The force on the test body due to the magnetic field is proportional to the difference in volume magnetic susceptibility of the test body and the gas surrounding it. The operation of the instrument is accordingly analogous to the ordinary determination of the density of a liquid by weighing a solid body suspended in the liquid (Archimedes' principle). The test body in the meter is a small dumbbell consisting of two thin-walled glass spheres about 3 mm. in diameter connected by a small glass rod or tube about 4 mm. long; this dumbbell, which weighs about 2 mg., is cemented, together with a small mirror, to a silica fiber about 3 microns in diameter and about 10 mm. long which is stretched across a silica fork. By rotating around the silica fiber, which serves as a torsion balance, the spheres of the dumbbell may move in an inhomogeneous magnetic field. The field is produced by permanent magnets (usually two Alnico V horseshoe magnets weighing about 5 ounces apiece) with suitably shaped soft iron pole pieces. The magnetic susceptibility of the gas in the chamber (with gas volume about 4 ml.) surrounding the test body may be indicated on a scale by a beam of light reflected from the small mirror.

Several hundred of the meters have been manufactured, the first few dozen by the California Institute of Technology, and the others by Dr. Arnold O. Beckman, 11 West State Street, Pasadena 2, California, who took over the production of the meter in the Summer of 1942. The meter is made in several models for various special purposes and to cover various ranges of partial pressure of oxygen. The precision is dependent on the range; it is, for example, about ±1 mm. of mercury for a meter covering the partial pressure range 0 to 180 mm. of mercury. Some recording models of the instrument are available.

Our principal collaborators in the development of the instrument at the California Institute of Technology were David P. Shoemaker, James B. Edson, Harold Herd, Dr. Herbert Sargent, Dr. Charles D. Wagner, and Beckie Bradford. Professor H. Victor Neher gave us valuable advice and instruction in silica-fiber technique.

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[2] The paramagnetic gases, nitric oxide, nitrogen dioxide, and chlorine dioxide, if present, would also contribute largely to the magnetic susceptibility of the gas.

Quantitative Differentiation of Minute Amounts of the Coproporphyrin Isomers (I and III) Based on Fluorescence Behavior[1]

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The coproporphyrin isomers have identical absorption and fluorescence spectra (*1*). Other physical characteristics of differential nature, such as the ester melting point and pH fluorescence curves, require relatively large amounts of crystalline material. The concentration of coproporphyrin in normal and pathological urines is usually in the range of 50–500 γ per 24-hour sample, so that any method which requires crystallization prior to determination of the percentage of isomers in the mixture is unsatisfactory, simply

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